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DEVELOPMENT AND APPLICATION OF A TWO-TIER DIAGNOSTIC TEST TO ASSESS SECONDARY STUDENTS' UNDERSTANDING OF CHEMICAL EQUILIBRIUM CONCEPTS

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Abstract. *The purpose of this study is to develop a two-tier multiple choice test to detect tenth grade high school students' conceptual understanding related to chemical equilibrium. In the development of the test the steps described by Treagust (1988) were used. The test was prepared for the purpose of detecting students' conceptual understanding in topics like approach to equilibrium, equilibrium state, changes in the equilibrium conditions, addition of inert gas and catalyst. The test was administered to 102 tenth grade students. The internal validity coefficient of Cronbach alpha was 0.903. Difficulty indices ranged from 0.20 to 0.93, and discrimination indices ranged from 0.19 to 0.89. Each item was analyzed to determine student understanding and identify alternative conceptions about, chemical equilibrium concept. Results of the test suggested students did not acquire a satisfactory understanding of chemical equilibrium concepts and 25 common students' alternative conceptions were identified through analysis of test items.*

Key words: *alternative conception, chemical equilibrium, high school, two-tier multiple choice test.*

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Introduction

Students come to classroom milieu by having lots of pre-knowledge related to natural phenomena based on their own experiences and observations. When we want to plan an instruction that is based on constructivist approach, the students' pre-knowledge, alternative conceptions and the reasons of these conceptions are to known by the teacher. Because, learning is a process that is based on students' pre-knowledge and the teacher needs students' pre-knowledge and alternative conceptions in order to make the students' conceptual change easier. Because of this, in the learning process the materials that can be used in short term in classroom should be developed to achieve meaningful learning in students and to detect students' alternative conceptions.

For this purpose in literature, multiple choice tests (Helm, 1980; Trembath, 1984; Haslam & Treagust, 1987), two-tier multiple choice tests (Treagust, 1988; Peterson, Treagust & Garnett, 1989; Tan, Goh, Chia & Treagust, 2002; Lin, 2004), concept maps (Novak, 1996) and interviews (Osborne & Gilbert, 1980; Carr, 1996) are heavily used. In detecting students' pre-knowledge, multiple choice tests and true-false questions can be used. Using and evaluating this kind of questions is easy. However, with this kind of questions only student's knowledge related with the content can be understood, but the underlying reasons for their choices can not be revealed. Interviews can be applied in order to reveal students' ideas and the reasons for these ideas. However, there are some limitations: Interviews take too much time, changing interview results into points is difficult. The concept maps can be also used in detecting students conceptions. In this technique, there are some limitations: Students don't know this technique enough, the application take too much time and changing results into points is not easy as in multiple choice questions. However, two-tier multiple choice questions are very useful both in detecting students' conceptions and in understanding the underlying reasons for these conceptions. Moreover, both planning and rating these tests are easy. For this reason, two-tier multiple choice tests are relatively advantageous techniques to detect students' conceptions and alternative conceptions following the interviews. In detecting students' pre-knowledge and alternative conceptions, Treagust suggested two-tier multiple choice tests that are based on the reasons of the student conception. In many topics in chemistry education, two-tier multiple choice tests are used to detect student conceptions (Treagust, 2006).

In two-tier multiple choice tests, each question consists of two tiers. In the first step, there is one right answer and the distracters. In the second step, there are the possible answers which consist of student alternative conceptions and can be given to the choices in the first step, and the reason of the right answer. In chemistry education in many topics, two-tier multiple choice tests are used in order to detect student conceptions: Chemical bonds (Peterson, Treagust & Garnett, 1989; Tan & Treagust, 1999; Birk & Kurtz, 1999), chemical equilibrium (Tyson, Treagust & Bucat, 1999; Atasoy, Akkus & Kadayifci, 2009), chemical reactions (Chandrasegaran, Treagust & Mocerino, 2007), ionization energy (Tan, Taber, Goh & Chia, 2005).

Purpose of this Study

The purpose of the study is to develop a two-tier multiple choice test in order to detect tenth grade high school students' conceptual understanding related to chemical equilibrium and to document common alternative conceptions related to chemical equilibrium.

Research Focus

Studies conducted in science education in the last 30 years showed that students have alternative conceptions in variety of topics (Duit & Treagust 2003). Teachers' awareness of their students' alternative conceptions will lead them to take necessary actions to prevent the construction of alternative conceptions in students' minds or dispel already existing alternative conceptions. Moreover, teachers want to identify students' alternative conceptions or assess students' conceptual understanding following their instruction by using no time-consuming instruments. Two-tier multiple choice tests are useful for these purposes as they can be administered to large group of students and in a short time and they provide the reasons behind students' responses. The main focus of this research was to develop a two-tier diagnostic instrument to identify students' alternative conceptions regarding chemical equilibrium.

Methodology of Research

General Background of Research

Studies showed that students` conceptual understanding in science is limited and students have misconceptions (alternative conceptions) in a variety of science concepts (Duit & Treagust 2003). Moreover, the results of some studies indicate that teachers do not efficiently identify their students` learning difficulties at the beginning of their instruction (Duit & Treagust 2003). There are suggestions related to teachers' determining the learning difficulties of students in the literature such as organizing education according to constructivist approach (Bell, 2000; Black, 1999; Treagust, Jacobwitz, Gallagher & Parker, 2001), rearranging curriculums to include formal and informal evaluation procedures (Wiggins & McTigue, 1998). According to these authors, teachers should use formative and summative evaluation methods extensively to enable student understanding. However, the difficulty in using many effective methods is the fact that it takes too much time of teachers (Treagust, 2006). Two tier multiple choice tests are useful instruments that can be used by teachers to identify their students` preconceptions and evaluate their instruction (Costa, Marques & Kempa 2000; Taber 2001; Treagust, 2003). Therefore, in this study a two-tier multiple choice test was developed to assess students' conceptual understanding

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about chemical equilibrium by using the test developed by Hackling and Garnett (1985) which consists of single tier multiple choice test and true false item.

Sample of Research

The present study consisted of 102 10th grade students composed of 45 females and 57 males and whose ages changes between and 16 and 17 of a general chemistry course in a high school. General chemistry is a 4 year course in which chemical equilibrium concepts are covered during the second semester of the second year of secondary education (10th grade).

The Development of Concept Test Related to Chemical Equilibrium

The two-tier multiple choice test about chemical equilibrium is constructed by the researchers based on the single-tier multiple choice and true-false test developed by Hackling and Garnett (1985). This single-tier test was converted into a two-tier test using the stages suggested by Treagust (1988, 1995). The test developed by Hackling and Garnett (1985) includes 10 true-false and 37 multiple choice questions, making a 47 in total. In true-false and multiple-choice tests, the reason of student's answer is not known. In order to plan an instruction that is based on constructivist approach, the students' ideas and underlying reasons for these ideas are to be known. So, it is a necessity to use two-tier multiple choice tests. For this purpose, the test which is developed by Hackling and Garnett is changed by us into two-tier multiple choice test. The test consists of 46 questions. In the test, in the first step of the each question there are the right answer and the distracters and in the second step, the reason of the right answer and the alternative conceptions. The test was prepared to detect students' conceptual understanding related to chemical equilibrium with the questions that includes the changes approach of the system to equilibrium; the equilibrium situation; the changes in the equilibrium conditions (temperature and concentration, pressure, volume, removal or addition of species in the equilibrium, and change); inert gas addition; and catalyst addition situations. The preparation steps of the test according to steps which are advised by Treagust (1988, 1995) are shown in the figure below.

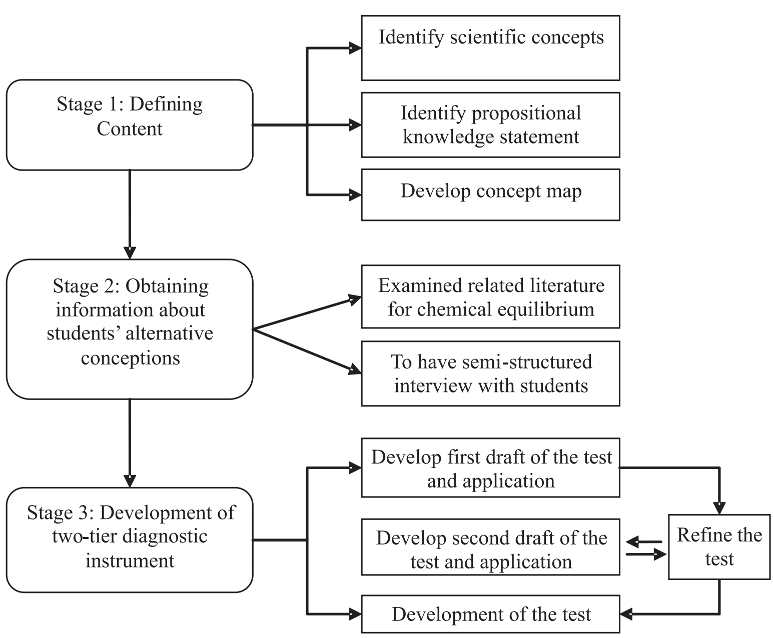

Figure 1: Stages in the development of two-tier multiple choice test based on methodology proposed by Treagust (1988, 1995).

In the preparation process of two-tier multiple choice tests that are related to chemical equilibrium, the stages that are suggested by Treagust (1988, 1995) were made use of. The first one of these stages is "defining content frame"; in this stage by preparing a concept map related to chemical equilibrium and preparing a list of the suggested knowledge, the content is determined. The second stage is "defining student alternative conceptions"; in this stage semi-constructed interviews that take 25-30 minutes for each student were done with 17 students. The interviews were recorded and analyzed. Also, to detect students' alternative conceptions related to chemical equilibrium the relevant literatures were examined (e.g, Johnstone, Macdonald & Webb, 1977; Wheeler & Kass, 1978; Hackling & Garnet, 1985; Gorodetsky & Gussarsky, 1986; Bergquist & Heikkinen, 1990; Banerjee, 1991; Hameed, Hackling & Garnett, 1993; Quilez-Pardo & Solaz-Portoles, 1995; Voska & Heikkinen, 2000; van Driel & Gräber, W. 2002; Akkus, Kadayıfçı, Atasoy, & Geban, 2003). The alternative conceptions that are derived from the literature search and the interviews are used in the second part of the questions, the reason of you answer part. In the third part, making use of the data, two-tier multiple choice questions were prepared and whether the test questions represent the suggested knowledge that is used in determining the test questions' content was controlled. The test can be found at this address: http//w3.gazi.edu.tr/web/batasoy/cect.pdf

Statistical Analysis

The answer to an item was considered to be correct if both content and reason parts were correctly answered. The content validity of the test was determined by a group of chemistry educators who are expert in science education. The reliability of the test was generated by calculating the Cronbach alpha coefficient based on the data collected from 102 tenth grade students. The Cronbach alpha was found as 0.903. This value is quite above the value (0.70) which are pointed by Nunally (1978) for multiple choice questions. When the item difficulty index of the questions is examined, it is seen that only the index of seven questions is below 0.40 out of 46 questions. When the item discrimination index of the questions is examined, out of 46 questions the discrimination index of 28 questions is very good (between 0.41 and 0.89), for seven questions it is good (between 0.30 and 0.39), for one question it is average (between 0.20 and 0.29), for ten questions it is poor (< 0.20). See table 1.

The frequency of students' alternative conceptions were calculated based on thee responses of the 102 students to the 46 items in the Chemical Equilibrium Concept Test. Table 2 shows that the percentage of students who have alternative conceptions assessed by different items in the test ranges from %19 to %40.

Table 1. Item difficulty and Item discrimination index.

Item difficulty index	Item Number	Item discrimination Index	Item Number
0,70-0,93	8, 22, 9, 25, 23, 24, 34, 26, 3, 13, 35, 37, 2, 36, 11, 28	Very good (between 0.40 and 0.89),	38, 41, 42, 44, 45, 33, 46, 39, 40, 10, 32, 43, 7, 29, 1, 15, 31, 6, 12, 14, 16, 21, 36, 20, 30, 35, 27, 34
0,50-0,69	6, 30, 15, 27, 14, 16, 29, 21, 31, 45, 7, 38, 12, 18, 20, 42, 41, 32, 43, 44	Good (between 0.30 and 0.39)	26, 28, 4, 5, 13, 17, 37
0,33-0,48	33, 46, 17, 39, 40, 4, 10, 1	average (between 0.20 and 0.29)	9
0,20-0,22	19, 5	poor (< 0.20).	2, 11, 25, 3, 18, 22, 23, 24, 8, 19

Results of Research

The Application and Analysis of the Concept Test Related to Chemical Equilibrium

The developed test was applied to 102 tenth grade students composed of 45 females and 57 males and their conceptions and alternative conceptions related to chemical equilibrium were determined. After the application, each item was analyzed to determine student understanding and identify alternative conceptions about chemical equilibrium concept. The results of the study indicate that students did not have a satisfactory understanding of chemical equilibrium concepts and 25 alternative conceptions were identified through the analysis of test items. In the table 2 given below, the students' alternative conceptions related to chemical equilibrium are present.

Table 2. The common student alternative conceptions determined by chemical equilibrium concept test.

Test Items	Common students' percentages of alternative conceptions	
	Approach to Equilibrium	%
1	Beginning from the time that reactants are mixed until that the system has reached at equilibrium, as the forward reaction rate increases, while the products' concentration increases, the reactants' concentration decreases. But, due to stoichiometric coefficients, while Cl2 concentration equals to the products' concentration by decreasing, NO concentration decreases much more. In addition, in an equilibrium reaction, whether one of the reactants will be completely used up is found by looking at stoichiometric coefficients.	21.57
4	If equilibrium constant of a reaction is big, product's concentration is bigger than reactant's concentration; therefore, reverse reaction rate is bigger than the forward reaction rate.	36.27
5	When the system is not in equilibrium in an equilibrium reaction, in a situation such as Q>Kd, as products' concentration is bigger than the reactants' concentration, forward reaction rate will be bigger than the reverse reaction rate.	40.20
	Adding Reactant to System Forward and reverse reaction rate	
10	In a reaction in equilibrium, when concentration of one of the reactants is increased (by adding a reactant), reverse reaction rate increases as equilibrium shifts to the left.	22.55
	In a reaction in equilibrium, when concentration of one of the reactants is increased (by adding a reactant), reverse reaction rate decreases as equilibrium shifts to the left.	27.45
12	In a reaction in equilibrium, after adding one of the species in the reactants, equilibrium is disrupted and after a while, when equilibrium is re-established, the rate of initial equilibrium and re-established equilibrium is the same. Because, in order that equilibrium is re-established it is essential that forward and reverse reaction rates must be like the one in initial equilibrium.	25.49
	Changing the Temperature of System Concentration of species in the equilibrium	
14	In a reaction that is exothermic and in equilibrium, after temperature is suddenly increased and when equilibrium is re-established, concentration of species in reactants will be smaller than its value in the initial equilibrium. Because, kinetic energy of particles increases as a result of the rise in temperature. As kinetic energy increases, more collision occurs and more products are produced. As more products are produced, the concentration of the reactants decreases.	24.51
16	In a reaction that is exothermic and in equilibrium, after temperature is suddenly increased and when equilibrium is re-established, the concentration of products will be bigger than its value in the initial equilibrium. Because, kinetic energy of particles increases as a result of temperature increase. As more collision occurs, the more products are produced and product concentration increases.	29.41
	Forward and reverse reaction rate	
17	In a reaction that is exothermic and in equilibrium, when the temperature is suddenly increased, the forward reaction rate decreases. The reason is that in an exothermic reaction, an increase in the temperature causes decrease in forward reaction rate while it increases reverse reaction rate.	42.16

Test Items	Common students' percentages of alternative conceptions	
18	In a reaction that is exothermic and in equilibrium, when the temperature is suddenly increased, reverse reaction rate increases. Because, in an exothermic reaction, increase in temperature decreases forward reaction rate while it increases reverse reaction rate.	38.24
19	In a reaction that is exothermic and in equilibrium, when the temperature is suddenly increased, forward reaction rate will be bigger than reverse reaction rate. Because temperature rise increases the kinetic energy of particles, forward reaction rate is bigger that reverse reaction rate.	21.57
20	In a reaction that is exothermic and in equilibrium, after temperature is suddenly increased and when equilibrium is re-established, the forward and reverse reaction rates of the re-established equilibrium will be equal to their value in the first equilibrium. Because both of them are in the same equilibrium, there is no difference in terms of reaction rates.	36.27
27	In constant temperature in a reaction in equilibrium, when the volume of the system decreases suddenly, reverse reaction rate decreases. Because the number of the particles per unit decreases as a result of volume reduction, forward reaction rate decreases.	20.59
29	In constant temperature in a reaction in equilibrium, after when the volume of the system decreases suddenly and when equilibrium is re-established, the forward and reverse reaction rates of the re-established equilibrium will be equal to their value in the first equilibrium. Because both of them are in the same reaction, there is no difference in terms of forward and reverse reaction rates.	27.45
	Changing The Volume of System Equilibrium constant	
	$2NO(g) + Cl2(g) \leftrightarrows 2NOCl(g)$ + energy	
30	In a reaction that is in equilibrium in a constant temperature, when system's volume is suddenly decreased, when equilibrium is re-established, the value of equilibrium constant will be bigger than its value in the initial equilibrium. Because, when volume is decreased, concentration increases. Equilibrium constant also increases because it is concentrations ratio.	18.63
	Addition Catalyst to System	
	Forward and reverse reaction rate	
31	In reaction that is in equilibrium, when catalyst is added to system while pressure, volume and temperature is constant, forward and reverse reaction rates will not change. Because, addition of catalyst to a system which has reached equilibrium doesn't affect reaction rates.	20.59
33	In reaction that is in equilibrium, when catalyst is added to system while pressure, volume and temperature is constant, forward and reverse reaction rates will not change. Because, addition of catalyst to a system which has reached equilibrium doesn't affect reaction rates.	20.59
	Adding Inert Gas to System Concentration of species in the equilibrium	
38	In reaction that is in equilibrium, when inert gas is added to system while pressure and temperature is constant, concentration of species in reaction will not change. Because inert gas doesn't reaction with the species in equilibrium, concentrations will not change.	29.41
39	After inert gas is added to a reaction vessel in constant pressure and temperature, when equilibrium is re-established, NO concentration will be smaller than its value at the time inert gas was added. That is because addition of inert gas at constant pressure will lead to an increase in volume and decrease in concentration. Because system tends to shift in the direction of products in order to reduce the effect of the decrease in concentration, NO concentration will decrease.	25.49
	NO concentration will be equal to its value when inert gas added. Because inert gas doesn't reaction with the species in equilibrium, concentrations will not change.	21.57
40	After inert gas is added to a reaction vessel in constant temperature, when equilibrium is re-established, concentration of Cl2 will be smaller than its value at the time inert gas was added. Because at constant pressure, inert gas addition causes increase in volume and decrease in concentration. Therefore, concentration of Cl2 will decrease.	31.37
	After inert gas is added to the above reaction in equilibrium and in constant temperature, when equilibrium is re-established, concentration of Cl2 will be equal to its value at the time inert gas is added. Because inert gas doesn't reaction with the species in equilibrium, concentrations will not change.	22.55
41	NOC1 concentration will be equal to its value at the time inert gas is added. Because inert gas doesn't react with the species in equilibrium, concentrations will not change.	22.55

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Test Items	Common students' percentages of alternative conceptions	
	Forward and reverse reaction rate	
42	When inert gas is added to system in a reaction that is in equilibrium and in constant temperature and pressure, forward reaction rate doesn't change. Because inert gas doesn't react with the species in equilibrium, concentrations will not change.	26.47
43	When inert gas is added to system in a reaction that is in equilibrium and in constant temperature and pressure, reverse reaction rate doesn't change. Because inert gas doesn't react with the species in equilibrium, concentrations will not change.	25.49
44	When inert gas is added to system in a reaction that is in equilibrium and in constant temperature and pressure, the rate of forward reaction rate will be equal to reverse reaction rate. Because inert gas doesn't react with the species in equilibrium, it doesn't affect the rate of reaction.	33.33
45	After inert gas is added to a reaction vessel in constant pressure and temperature, when equilibrium is re-established, the forward and reverse reaction rate of the new equilibrium will be equal to the one in initial equilibrium. The reason is because inert gas does not react into reaction with species in the equilibrium, it does not affect their rate. Or, because it is the same reaction, forward reaction rate will be equal to reverse reaction rate.	24.51
	Equilibrium constant	
46	After inert gas is added to a reaction vessel in constant pressure and temperature, when equilibrium is re-established, the equilibrium constant value of the new system will be smaller than its value in the initial equilibrium. The reason is because addition of inert gas causes decrease in concentration of species in equilibrium, the value of equilibrium constant will decrease.	20.59

Note: in the table, the values which have a ratio of student alternative conceptions above %19 are given.

In table 2, there are the student alternative concepts related to chemical equilibrium. The alternative conceptions of the students and the examples including these alternative conceptions' reasons, which are obtained with the help of the developed two-tier multiple choice test, are given in the following lines.

In the questions related to approach the system in equilibrium, one of the common alternative conceptions was that if equilibrium constant of a reaction is big, product's concentration is bigger than reactant's concentration; therefore, reverse reaction rate is bigger than the forward reaction rate (36.27%). Another alternative conception When the system is not in equilibrium in an equilibrium reaction such as Q>Kd, as products' concentration is bigger than the reactants' concentration, forward reaction rate will be bigger than the reverse reaction rate (40.20%).

In the questions related to the temperature increase in a system in equilibrium, one of the common alternative conceptions was that when the temperature is suddenly increased in an exothermic reaction in equilibrium and when equilibrium is re-established, products' concentrations will be bigger than their value in the initial equilibrium. As a reason for this students indicated that as kinetic energy of particles increases when temperature increases and because there is more collision; more products are produced so that products' concentration will increase (29.41%). Another alternative conception for the same question was that the concentration of the reactants will be smaller than its value in the initial equilibrium. As a reason for this, students indicated that kinetic energy of particles increases as a result of temperature increase and causes more collision. For this reason, there will be more products leading decrease in reactants' concentrations (42.16%).

A higher percentage of the students made incorrect predictions related to the effects of changing equilibrium conditions (changing concentration, temperature, and volume) on the rate of the forward and reverse reactions. A common alternative conception was that while the rate of the favored reaction is increased, the other reaction rate is decreased. For example, 42.16% of the students indicated that in an exothermic reaction, the increase in temperature will also increase reaction rate in one direction while it decreases reaction rate in another direction.

In the questions related to the addition of the inert gas to the system in equilibrium, 25.49% of students gave the answer: "After an inert gas is added to a reaction in constant pressure and temperature, when equilibrium is re-established, NO concentration will be smaller than its value at the time inert gas was added. That is because addition of the inert gas at constant pressure will lead to increase in volume and decrease in concentration. Since system tends to shift in the direction of products in order to reduce the effect of the decrease in concentration, NO concentration will decrease. As to the forward and reverse reaction rate, 26.47% of the students thought that because inert gas did not enter into reaction with species in equilibrium, the forward and reverse reaction rate will not change. 20.59% of the students thought that because at constant pressure, an inert gas causes a decrease in concentration of species in equilibrium, the quantitative value of equilibrium constant will decrease.

In the question related to adding inert gas to the system that is in equilibrium and in constant temperature and pressure, approximately one-third of the students stated that equilibrium constant will not change because inert gas will not enter reaction. 20.59% of the students stated that the volume will rise as inert gas is added in constant temperature and as a result of this the concentration of the species in equilibrium will decrease and because of that the value of the equilibrium constant will decrease.

After inert gas is added to a reaction in equilibrium, vessel in constant pressure and temperature, when equilibrium is re-established, the equilibrium constant value of the new system will be smaller than its value in the initial equilibrium. The reason is because addition of inert gas causes decrease in concentration of species in equilibrium, the value of equilibrium constant will decrease

Discussion

The findings that we have at the end of this study are in agreement with the findings that are made in this field (Hackling & Garnet, 1985; Gorodetsky & Gussarsky, 1986; Bergquist & Heikkinen, 1990; Banerjee, 1991; Hameed, Hackling & Garnett, 1993; Akkus, Kadayifci, Atasoy & Geban, 2003). Results of the test suggested that students did not acquire a satisfactory understanding of chemical equilibrium concepts and twenty five alternative conceptions were identified through analysis of test items (see table 2).

In determining the student conceptions, instruments such as concept maps (Novak, 1996), interviews (Osborne & Gilbert, 1980; Carr, 1996), multiple choice diagnostic instrument (Treagust, 1995) and true-false are used. But when true false and multiple choice tests are applied in determining the student alternative concepts, the reason of student's answer is not known. If we want to know the reasons of alternative conceptions, such techniques as interviews (Osborne & Gilbert, 1980; Carr, 1996), concept maps (Novak, 1996), prediction-observation-explanation (White & Gunstone, 1992) are used. In the application of these techniques, there are some limitations like the applications' taking too much time and the difficulty of changing data into points. However, both the application of two-tier multiple choice tests and changing them into points are easy, at the same time they help us in understanding underlying reasons of the student's alternative conceptions. Chen and Lin (2003) pointed that two-tier multiple choice test provided a reliable and valid pencil-paper test, easy to score for science teachers and researchers to better evaluate for students ideas. Also, Chou (2004) pointed two-tier test helped teachers teach and students learn better. For these reasons, this test can be applied in determining students' conceptual understandings related to chemical equilibrium and alternative conceptions of students. Interviews must be used if it is wanted to examine the reasons of students' alternative conceptions thoroughly. Two-tier multiple choice tests can be used easily in determining alternative conceptions of students.

The studies conducted in the field of science education show that teachers do not effectively identify students' learning difficulties at the beginning of their instruction (such as Costa, Marques & Kempa 2000; Taber 2001). Two tier multiple choice tests can be used by the teachers to identify not only students' alternative conceptions but also the reasons behind their alternative conceptions.

Conclusions

Two-tier multiple choice diagnostic test appeared to provide a feasible approach to asses students' understanding and to identify alternative conception related with Chemical equilibrium concepts. The two-tier multiple choice diagnostic instrument provided data which show that 10th grade students

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have high amount of alternative conceptions related to (a) approach to equilibrium, (b) equilibrium state (c) changes in the equilibrium conditions (temperature, concentration, volume, pressure, the addition and omission of species in the equilibrium to the equilibrium system), (d) addition of inert gas and catalyst (see table 2).

According to this data, two-tier multiple choice tests will make providing conceptual understanding of students easy for the teacher on account of determining the reasons of alternative concepts of students, obtaining the ratio of frequency in students and the teacher's being aware of these alternative concepts and their reasons.

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